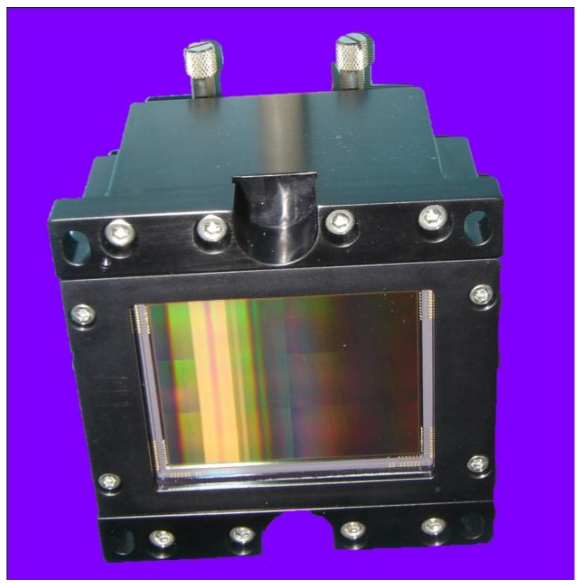
PANTERA 22M

Camera User's Manual

CA-40-22M03-00-L



Progressive Scan Monochrome Camera

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www.teledynedalsa.com
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Teledyne DALSA, a Teledyne Technologies company, is an international leader in high performance digital imaging and semiconductors with approximately 1,000 employees worldwide, headquartered in Waterloo, Ontario, Canada. Established in 1980, the company designs, develops, manufactures and markets digital imaging products and solutions, in addition to providing MEMS products and services. For more information, visit Teledyne DALSA's website at www.teledynedalsa.com.

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Introduction to the PANTERA 22M Area/TDI Scan Camera

1.1 Camera Highlights

Features

- 4008(H) x 5344(V) resolution, full frame CCD architecture
- The PANTERA 22M offers up to 3.6 fps, 4 outputs at full resolution, 27 MHz data rate
- Up to 12 bit digitization
- Small gain steps to achieve extremely low seam mismatch between taps
- High sensitivity with low dark current
- Area or TDI mode
- Exposure control and antiblooming
- Asynchronous image capture, externally triggerable
- Tap to tap matching
- 100% fill factor
- Single 12VDC power supply

Programmability

- Simple ASCII protocol controls gain, offset, frame rates, trigger mode, test pattern output, and camera diagnostics
- Serial interface (ASCII, 9600 baud, adjustable up to 115200), through Camera Link™

Description

The PANTERA 22M digital cameras provide high-sensitivity 12 bit images with a 4008 x 5344 spatial resolution. The cameras use the full frame FTF4052M sensor to simultaneously achieve outstanding resolution and gray scale characteristics. A square pixel format and high fill factor provide superior, quantifiable image quality even at low light levels.

Applications

The PANTERA 22M are outstanding performers in fast, very high resolution applications. 12 bit performance provides up to 4096 distinct gray levels—perfect for applications with large interscene light variations. The low-noise, digitized video signal also makes the camera an excellent choice where low contrast images must be captured in challenging applications.

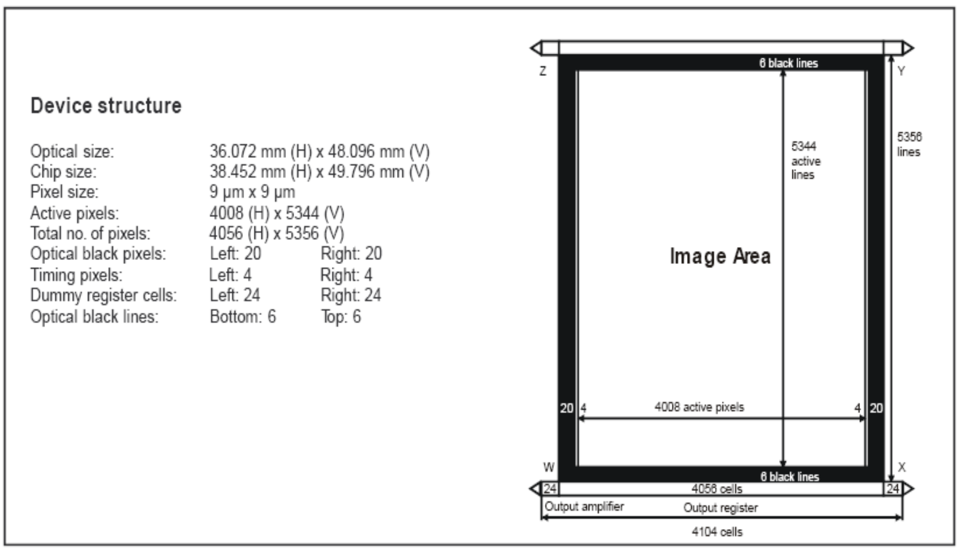
Specific applications include:

- Flat panel inspection
- Microscopy
- Aerial reconnaissance
- Medical and non-destructive test x-ray

1.2 Image Sensor

The PANTERA 22M offers frame rates at up to 3.6 frames per second (fps) using 4 output taps to simultaneously read out data. This camera uses the FTF4052M full-frame CCD image sensor. The FTF4052M provides the highest possible image quality for its resolution, with lower dark current, lower noise, and higher dynamic range than any competitor.

Figure 1: FTF4052M Image Sensor



1.3 Camera Performance Specifications

Table 1: PANTERA 22M Camera Performance Specifications

Camera Features	Units		Notes
Resolution	H x V pixels	4008 x 5344	
Pixel Size	µm	9 x 9	
Pixel Fill Factor	%	100	
Output taps		4	

Mechanical Interface	Units		Notes
Size	mm	78 x 78 x 70	
Weight	kg	0.65 ± 5%	

Electrical Interface	Units		Notes
Power Dissipation	W	< 10	
Input Voltage	VDC	12 15	
Power Connector		6 pin Hirose	
Data Output Format	Bits	12/ 10/ 8	
Data Connector		Base Camera Link™ MDR26	

Optical Interface	Units		Notes
Back Focal Distance	mm	4.5±0.5	
Lens Mount		Not present	
Aperture	mm	36.072x48.096	
Sensor Alignment			
x, y	µm	±350	
z		±500	
Θz	º	±1.25	
Parallelism/ Tilt	µm	<900 over sensor	
Sensor Flatness	µm	40 peak-peak	

Camera Performance	Units	Min.	Nom.	Max.	Notes
Frame Rate	fps			3.6	
Data Rate	MHz	4x27			
Data Format		8, 10, or 12 bit user selectable			

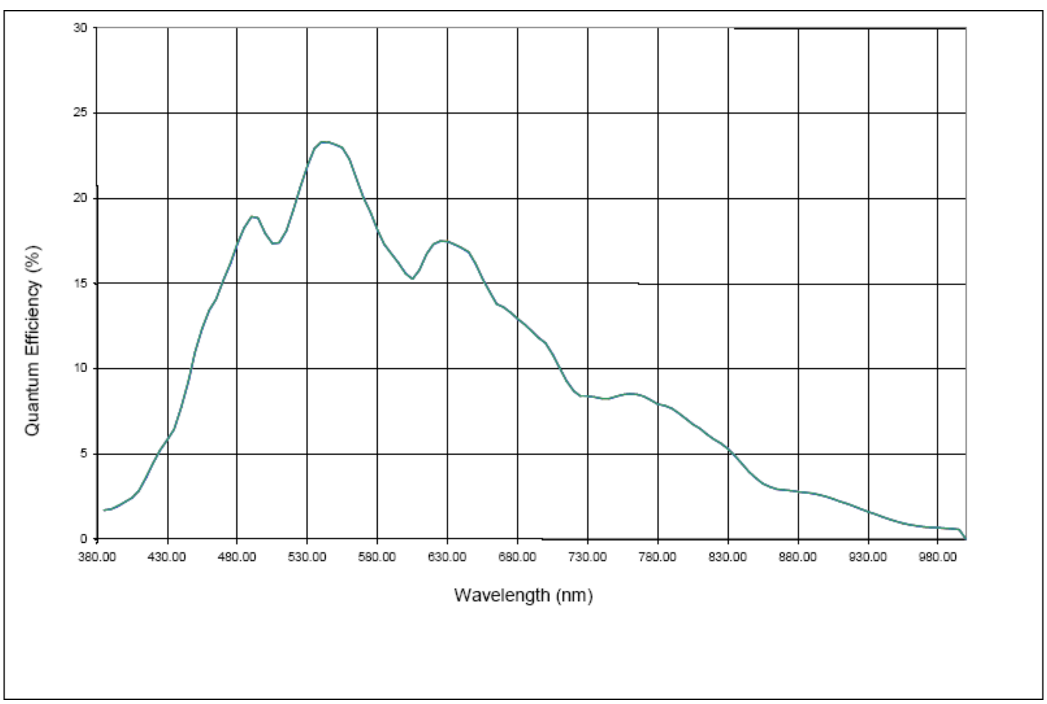
Operating Temp	°C	-10		50	At front plate
Gain Range	dB	0		24	
Dynamic Range	dB	63			
Pixel Response Non-Uniformity (PRNU)	DN rms			5	
Fixed Pattern Noise (FPN)	DN rms			3	
Sat. Output Amplitude	DN	3680	3840	4000	1
DC Offset	DN	80	160	240	1
Antiblooming				>100x	1
Responsivity	DN/ (nJ/ cm^2)	19	20	21	12-bit @530nm
Power Up Duration	sec			10	
Power Up Stabilization time	min			30	

Regulatory		
Regulatory Compliance	None	

Notes:

1. Nominal output, 100ms exposure time. Light source: broadband quartz halogen, 3200K, 750nm and IR cutoff filter.

Figure 2 PANTERA 22M Spectral Responsivity



1.4 Blemish specification

PANTERA 22M camera includes an FTF4052M CCD image sensor, industrial grade. Blemish specification is presented below.

Below table shows FTF4052M Sensor Blemish Specifications, maximum number of blemishes permitted.

Description	IG (industrial grade)
Pixel defects	100
Cluster defects	12
Spot defects	0
Column defects	1
Row defects	0

Definition of blemishes

Pixel defect

Pixel whose signal, at nominal light (illumination at 50% of the linear range), deviates more than ±30% from its neighbouring pixels. Pixel whose signal, in dark, deviates more than 250mV from its neighbouring pixels.

Cluster defect

A grouping of at most 5 pixel defects within a sub-area of 3*3 pixels.

Spot defect

A grouping of more than 5 pixel defects within a sub-area of 3*3 pixels.

Column defect

A column which has more than 8 pixel defects in a 1*12 kernel.

Column defects must be horizontally separated by 3 good columns.

Row defect

A horizontal grouping of more than 8 pixel defects between at least 2 good pixels on both sides, where single good pixels between 2 defective pixels are considered as defective.

Test conditions

Temperature: 60°C

Integration Time: 100ms

2

Camera Hardware Interface

2.1 Installation Overview

This installation overview assumes you have not installed any system components yet.

In order to set up your camera, you should take these initial steps:

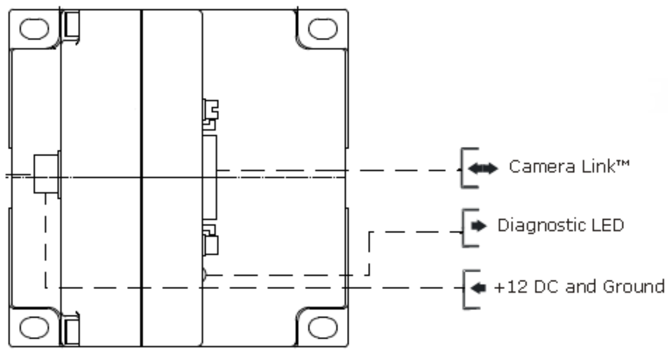
1. Power down all equipment.
2. Following the manufacturer's instructions, install the frame grabber (if applicable). **Be sure to observe all static precautions**
3. Install any necessary imaging software.
4. Before connecting power to the camera, test all power supplies. **Ensure that all the correct voltages are present at the camera end of the power cable** (The Camera Performance Specifications on page 6 list appropriate voltages). Power supplies must meet the requirements defined in 2.2.3 Power Connector Power Input.
5. Inspect all cables and connectors prior to installation. Do not use damaged cables or connectors or the camera may be damaged.
6. Connect data, serial interface, and power cables.
7. After connecting cables, apply power to the camera. After a few seconds, the LED on the back of the camera should be green to indicate that the camera is operating and ready to receive commands.

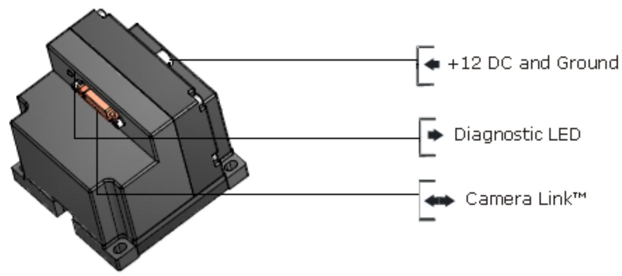
2.2 Input/Output Connectors and LED

The camera uses a:

- Diagnostic LED for monitoring the camera. See LED Status Indicator section below for details.
- High-density 26-pin MDR26 connector for Camera Link control signals, data signals, and serial communications. Refer to Figure 4: MDR26 Connector for pin descriptions.
- 6-pin Hirose connector for power. Refer to 2.2.3 Power Connector for pin descriptions.

Figure 3: Camera Inputs/Outputs





2.2.1 LED Status Indicator

Please refer to section 3.12 Monitoring the Camera, page 24 for detail.

2.2.2 Camera Link Data Connector

The Camera Link interface is implemented as a Base Configuration in the PANTERA 22M cameras. A Base Configuration uses 1 MDR26 connector and 1 Channel Link chip. The main characteristics of the Base Configuration are:

- Ports supported: A, B, C
- Serializer bit width: 28
- Number of chips: 1
- Number of MDR26 connectors: 1

Data Connector

Figure 4: MDR26 Connector

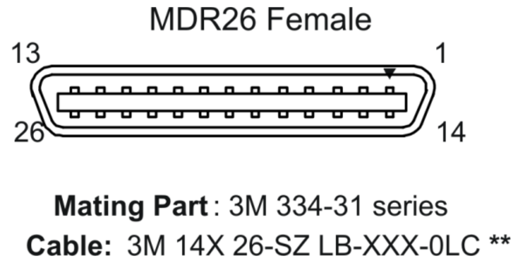


Table 2: MDR26 Connector Reference

Item	Value	Item	Value
Pinout	**BASE**	**Pinout**	**BASE**
1	GND	14	GND
2	X0-	15	X0+
3	X1-	16	X1+
4	X2-	17	X2+
5	Xclk-	18	Xclk+
6	X3-	19	X3+
7	SERTC+	20	SERTC-
8	SERTFG-	21	SERTFG+
9	CC1-	22	CC1+
10	CC2+	23	CC2-
11	CC3-	24	CC3+
12	CC4+	25	CC4-
13	GND	26	GND

Notes:

*Exterior Overshield is connected to the shells of the connectors on both ends.
**3M part 14X26-SZLB-XXX-0LC is a complete cable assembly, including connectors.
Unused pairs should be terminated in 100 ohms at both ends of the cable.

Table 3: Camera Control Configuration

Signal	Configuration
CC1	Smart EXSYNC(Area Mode)
CC2	Line Sync (TDI mode)
CC3	Area/ TDI mode
CC4	Spare

Digital Data

The camera digitizes internally to 12 bits and has a user selectable output of 8, 10, or 12 bits in LVDS format on the Camera Link connector. You can select the output using the clm command. For details, see section3.9 Setting the Camera Link Data Mode.

Data Clocking Signals

These signals indicate when data is valid, allowing you to clock the data from the camera to your acquisition system. These signals are part of the Camera Link configuration and you should refer to the Teledyne DALSA Camera Link Implementation Road Map, available with contacting Teledyne DALSA Technical support, for the standard location of these signals:

IMPORTANT:
This camera's data should be sampled on the rising edge of STROBE.

Clocking Signal	Indicates
LVAL (high)	Outputting valid line
DVAL (high)	Valid data
STROBE (rising edge)	Valid data
FVAL (high)	Outputting valid frame

See Appendix A for the complete Camera Link timing, Teledyne DALSA Camera Link configuration table, and contact Teledyne DALSA Technical support, for the official Camera Link document.

Input Signals

The camera accepts an EXSYNC control input through the Camera Link MDR26F connector.

EXSYNC (Triggers Readout)

For high speed communication the CC lines of camera link will be used.

The table below shows high speed controls:

Table 4: PANTERA 22M Camera Control Configuration

Camera Link input	Function	Note
CC1	Smart ExSync (Frame trigger and exposure control)	Will be ignored in TDI mode
CC2	Line sync	TDI mode only
CC3	0 - Area mode, split vertical transfer. 1 - TDI mode, one-way transfer	The direction of one-way transfer is set by software

2.2.3 Power Connector

Pin	Description	Pin	Description
1	+12V	4	GND
2	+12V	5	GND
3	+12V	6	GND

The camera requires a single voltage input (+12VDC to +15VDC). The camera meets all performance specifications using standard switching power supplies, although well-regulated linear supplies provide optimum performance.

When setting up the camera's power supplies follow these guidelines:

- Protect the camera with a fast-blow fuse between power supply and camera.
- Do not use the shield on a multi-conductor cable for ground.
- Keep leads as short as possible to reduce voltage drop.
- Use high-quality **linear** supplies to minimize noise.

Note: Performance specifications are not guaranteed if your power supply does not meet these requirements

WARNING: It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages will damage the camera. Protect the camera with a fast-blow fuse between power supply and camera.

Visit the www.teledynedalsa.com Web site for a list of companies that make power supplies that meet the camera's requirements. The companies listed should not be considered the only choices.

3

Software Interface: How to Control the Camera

All camera features can be controlled through the serial interface. The camera can also be used without the serial interface after it has been set up correctly. This chapter explains the most commonly used and important commands, including:

This chapter outlines the more commonly used commands. See Appendix B for a list of all available commands.

The serial interface uses a simple ASCII-based protocol. For a complete list of all available commands, refer to the Communications Protocol on page Commands and Error Handling.

Online Help

For quick help, the camera can return all available commands and parameters through the serial interface. To generate this list, send the command **h** to the camera.

Retrieving Camera Settings

To read current camera settings, send the command **gcp**.

3.1 Communications Protocol Overview

Serial Protocol Defaults:

- 8 data bits

- 1 stop bit
- No parity
- No flow control
- 9.6Kbps
- Camera does not echo characters

When entering commands, remember that:

- A carriage return (CR) ends each command. The linefeed character is ignored.
- The camera will answer each command with either "OK >" or "Error x: Error Message >". The ">" is always the last character sent by the camera.
- The following parameters are used throughout the manual:

  i = integer
  f = float
  t = tap
  [ ] = optional parameter

3.2 Overview: Setting up the Camera to Send Commands

The following steps describe how to begin using the PANTERA 22M and commands.

1. If you have not already set up your camera cables, connect your cables as described in section 2.1 Installation Overview.
2. Using a terminal program (e.g., Microsoft HyperTerminal), open a terminal window.

   Note: In order to communicate with the camera, a serial connection in the Camera Link cable needs to be established. The framegrabber manufacturers should be able to provide a solution in order to communicate through this serial link. The terminal software can be also provided by the framegrabber manufacturer. Standard terminal software such as HyperTerminal can be used in case if COM port is allocated by the framegrabber.

   Terminal should be set at 9600 baud during the camera power up.
3. When the terminal window is set up, power on the camera.
4. The boot-up message should appear on the terminal window:

   Configuration Successful.

   OK>

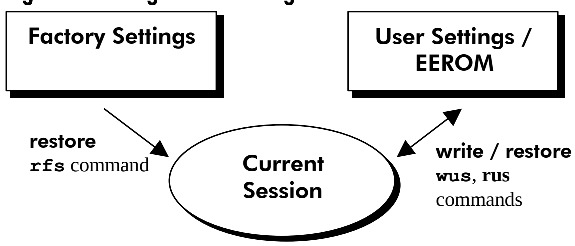
   You can now communicate with the camera through the terminal using the software commands described in this manual.
5. Set up the framegrabber to receive the data. Following the framegrabber manufacturer's instructions, set up the parameters described in the Camera Link™ Configuration Table on page 42.
6. Once the framegrabber is set up for data processing and the camera is powered up, run your image processing software. You should be able to see an image from the camera when exposed to a light source.
7. You can now set the other camera parameters described in this chapter.

3.3 Saving and Restoring Settings

The camera provides a number of commands for restoring, storing, and saving settings.

- To restore the original factory settings, use the command **rfs**.
- To save all current user settings to EEPROM, use the command **wus**. The camera will automatically restore the saved user settings when powered up.
- To restore the last saved user settings, use the command **rus**.

Figure 5: Saving and Restoring Overview



3.4 Setting Operating Mode

To select camera's operating mode, use the command:

Syntax:	*tdi i*	
Syntax Elements:	*i*	
	0	Area/ TDI mode (Selectable by CC3)
	1	Smart ExSync (Area Mode)
	2	Line Sync (TDI mode)
Related Commands:		
Example:	*tdi 1*	

3.5 Setting Exposure Mode and Exposure Time (Area Mode)

With three different exposure mode settings, the PANTERA 22Mcameras deliver many possibilities for flexible camera timing. Table outlines each of these three exposure modes, and is followed by a full explanation on how to set the camera's frame rate and exposure time.

For more information on the EXSYNC signal, refer to section 2.2 Input/Output Connectors and LED.

Mode 1 is the factory setting

Table5: Overview of PANTERA 22M Exposure Modes

Mode	SYNC	Exposure Time	Notes
0	–External	–Not programmable –Exposure time is set by the high pulse width of the iCC1 signal.	"Smart EXSYNC" Mode: external exposure time – high time of external signal is exposure time and 1/ period is frame rate. The rising edge of iCC1 begins camera exposure. The falling edge begins readout.
1	–Internal -Programmable –Frame rate is internally set to correspond with the programmed exposure time plus readout time.	–Internal –Programmable using the **set** command - Programmable using the **ssf** command	***Factory Default Mode.*** Frame period is the programmed exposure time plus the readout time. The frame period can be read in this mode by using the **gcp** command.
2	–External	-Programmable with **set** command	The user is responsible for not violating timing constraints for the EXSYNC signal used in this mode. The falling edge of EXSYNC initiates the frame transfer.

Overview: Setting Exposure mode and Exposure Time

The camera's frame rate (synchronization) can be generated internally through software commands or input externally from a frame grabber/ host system. To select how you want the camera's frame rate to be generated:

1. You must first set the camera mode using the **sem** command. Refer to Step One on the following for details.
2. Then, if you are using mode 1, use the **set** command to set the exposure time. Refer to Step Two in 3.5.2 for details. Then use the **ssf** to set the frame rate. Refer to 3.7 Setting Sync Frequency (TDI and Area Mode).

3.5.1 Step 1: Setting the Exposure Mode

In internal sync mode, (mode 1), the camera delivers data independent of external signals according to the timing set internally. In external sync modes (modes 2), the camera starts exposure after an external trigger pulse (iCC1).

To select camera's exposure mode, use the command:

Syntax:	***sem i***
Syntax Elements:	***i***

	0	Smart ExSync (Area Mode)
	1	Frame Sync Internal, Exposure Internal
	2	Frame Sync External, Exposure Internal
Notes:	▪	To obtain the current value of the exposure mode, use the command **`gcp`**.
Related Commands:	***`set`***	
Example:	***`sem 1`***	

Mode 0: Smart EXSYNC, External Frame Rate and Exposure Time

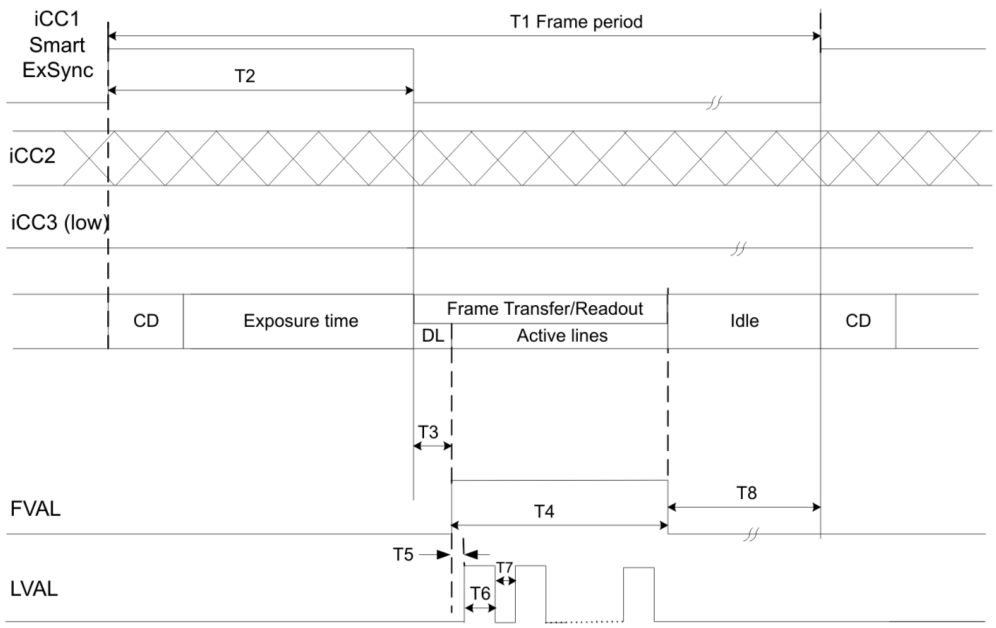


Figure5. Area mode timing diagram

The below table shows our recommended timing values,

Timing	Type	Recommended value	Remarks
T1	Variable	>276 ms	Frame period, maximum frame rate = 3.6 frames/ sec
T2	Variable	10 us + exposure time	iCC1 high length
T3	Typical	718.8 us	iCC1 falling edge to FVAL start
T4	Typical	275.3 ms	FVAL length for one frame

T5	Typical	27 us	FVAL start to LVAL start
T6	Typical	74.22 us	LVAL length
T7	Typical	28.75 us	LVAL end to next line LVAL start
T8	Variable	>1 ms	Idle time, depending on frame rate and exposure time

In Smart Exsync mode, the following events take place:

- Rising edge of iCC1 Frame Sync pulse is triggering charge dump(CD)
- Charge dump time which is fixed and set internally to 10µs
- After charge dump, exposure begins and lasts till iCC1 falling edge.
- the iCC1 falling edge causes frame transfer including vertical and horizontal readouts to begin.
- The first 6 lines of readout are dummy lines
- The next 2672 lines are active lines with video data
- At the end of the frame transfer the camera goes into idle operation state and remains in this state until a next iCC1 rising edge.

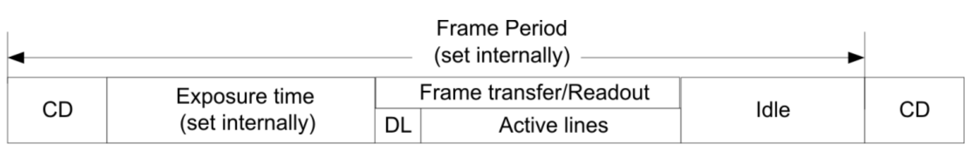
The duration of iCC1 pulse in high state should be larger than Charge reset time.

The frame period should be larger than the sum of charge dump time, exposure time, and the frame transfer time (including dummy and active lines).

The iCC3 signal should be driven LOW during area mode operation of the camera.

Mode 1: Internal Frame Sync and Internal Exposure Time

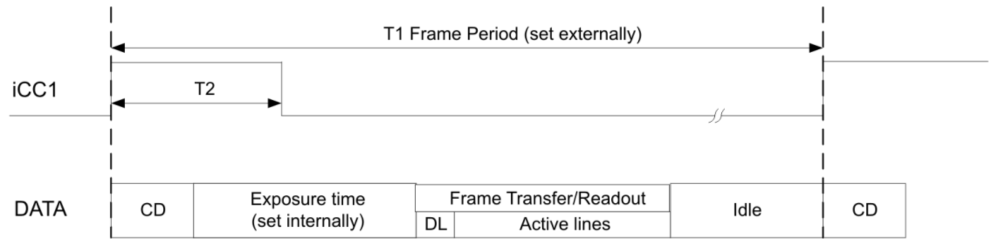
In this mode, the exposure time is programmed internally with the **`set`** command (described on following page); the frame rate is programmed internally with **`ssf`** command (described on following page). The Readout occurs immediately after the exposure time. After the readout is complete, the next exposure begins again. Both frame sync and exposure times are generated internally. The same restrictions as in mode 0 apply to this mode.



Mode 2: External Frame Sync and Internal Exposure Time

In this mode, iCC1 sets the frame rate but the exposure time is set internally using the software command, **set** (described on following page).

A new frame starts with iCC1 rising edge, then rest of processes are done internally, but identically to mode 0



The below table shows our recommended timing values,

Timing	Type	Recommended value	Remarks
T1	Variable	>276 ms	Frame period, maximum frame rate = 3.6 frames/ sec
T2	Fixed by user	100 us	iCC1 high length. Not critical as iCC1 falling edge doesn't trigger any action

3.5.2 Step 2: Setting Exposure Time

Setting Exposure Time

Camera must be operating in exposure mode 1, 2.

To set the camera exposure time, use the command:

Syntax:	***set i***	
Syntax Elements:	***i***	
		Floating point number in milliseconds. Allowable range is **1-10,000,000** microseconds.
Notes:	•	To read the current line rate frequency, use the command **gcp**.
	•	If you enter an invalid exposure time, the valid range of values will be displayed.
Related Commands:	***sem, ssf***	
Example:	***set 100,000***	

3.6 TDI Mode

In TDI mode, the following events take place:

- Rising edge of iCC2 Line Sync pulse or internal counter is triggering beginning of a new line
- New line starts with vertical transfer of one line
- Stop vertical transfer and start horizontal readout
- Read out dummy pixels
- Read out active lines. In parallel process data from active pixels. Enable LVAL for active pixels data.
- Overclock pixels, required for internal processing
- Idle state, waiting for next line sync

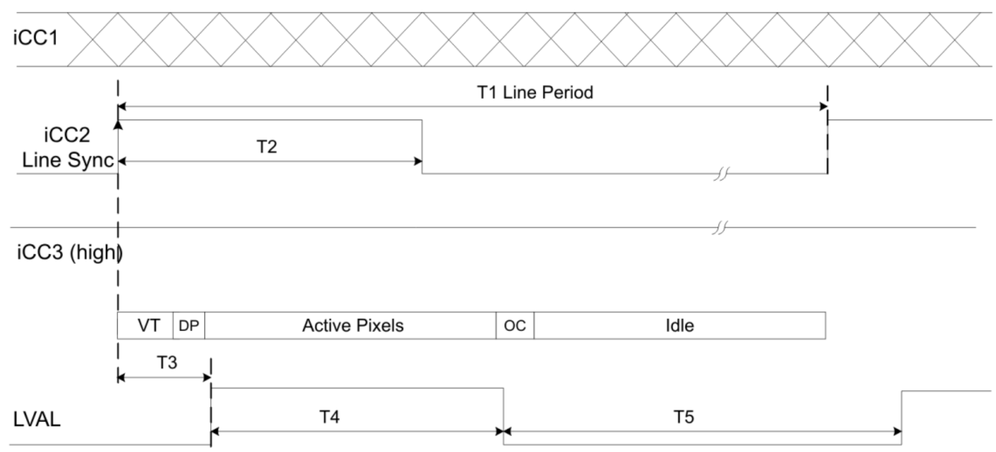


Figure 2. TDI mode timing diagram

The below table shows our recommended timing values,

Timing	Type	Recommended value	Remarks
T1	Typical	103us	Line period, set externally or internally Equivalent to 9.71kHz line rate
T2	Minimum	0.12-1 us	iCC2 high length. Not critical as iCC2 falling edge doesn't trigger any action
T3	Typical	28.7 us	Line Sync to LVAL start
T4	Typical	74.22 us	LVAL, slightly delayed from active pixels due to internal data processing

T5	Variable	1 us	Depending on line rate

If iCC2 (line sync) is running at higher rate than the maximum, the signal will be ignored.

When the camera operates in TDI mode, iCC3 is driven High and iCC1 value is ignored (so iCC1 could be driven either LOW – recommended, or High).

The sensor is exposed all the time and the lines are read with the frequency of the iCC2.

The value of FVAL will be set to LOW.

Setting TDI Direction (scd)

To set CCD scanning direction in TDI mode, use the command:

Syntax:	***scd i***	
Syntax Elements:	***i***	
	0	Top to bottom
	1	Bottom to top
Related Commands:	***tdi***	
Example:	***Scd 0***	

Setting Sync Mode (ssm)

To set sync mode to internal or external in TDI mode, use the command:

Syntax:	***ssm i***	
Syntax Elements:	***i***	
	0	Internal Line sync
	1	External line sync
Related Commands:	***tdi***	
Example:	***ssm 1***	

3.7 Setting Sync Frequency (TDI and Area Mode)

For both TDI and Area mode, to set the camera's frame rate and line rate values, use the command:

Syntax:	***ssf i i***	
Syntax Elements:	***i***	
	1	Frame rate: 278 – 16383 milliseconds
	2	Line rate: 2780 – 16383 counts of pixel clock

Notes:	• To read the current line rate frequency, use the command **gcp**. • If you enter an invalid frame rate or line rate, the valid range of values will be displayed.
Related Commands:	***sem, ssm***
Example:	***ssf 1 2780***

3.8 Switching between Area and TDI mode (TDI/Area Mode)

1. TDI mode to Area

   It is safe to switch from TDI mode to Area mode.
2. Area mode to TDI mode

   It is safe to switch during exposure time or idle time. If switched during frame transfer, the readout of full frame will be done first before the camera enters into TDI mode.

3.9 Setting the Camera Link Data Mode

The PANTERA 22M camera CameraLink port has two taps (channels), each are 12 bits. The 24 bits of data that are sent from the camera to the frame grabber are divided into three ports: A, B, C. Each port is 8 bits. The **clm** command selects the number of bits that the camera sends to the frame grabber from each tap. In the table below, ports A-C refer to the camera link specification.

To select the bit resolution for data sent via the CameraLink interface, use the command:

Syntax: ***clm i***

Syntax Elements: ***i***

0 12 bit (Factory setting),

Tap 1 Data bits 0 to 7 are linked to Port A
Tap 1Data bits 8 to 11 are linked to Port B bits 0 to 3
Tap 2 Data bits 8 to 11 are linked to Port B bits 4 to 7
Tap 2 Data bits 0 to 7 are linked to Port C

1 10 bit,

Tap 1 Data bits 0 to 7 are linked to Port A
Tap 1 Data bits 8 and 9 are linked to Port B bits 0 and 1
Tap 2 Data bits 8 and 9 are linked to Port B bits 4 and 5
Tap 2 Data bits 0 to 7 are linked to Port C

2 8 bit,

Tap 1 Data bits 0 to 7 are linked to Port A
Tap 2 Data bits 0 to 7 are linked to Port B

Notes: • To obtain the current output data format, use the command **gcp**

Example: ***clm 0***

3.10 Setting Baud Rate

Change speed of camera serial communication port. Default speed of communication after power-on cycle is always 9600 baud.

Parameters of serial communication are as follows:

- Eight (8) data bits
- No (N) parity
- One (1) stop bit
- No hardware flowcontrol

To set the speed of the camera serial communication port, use the command:

Syntax: *`sbr i`*

Syntax Elements: *`i`*

Baud rate. Available baud rates are: **`9600`** (Default), **`14400, 19200`**, **`28800`**, and **`115200`**.

Notes:

- Power-on rate is always 9600 baud.
- The **`rc`** (reset camera) command will *not* reset the camera to the power-on baud rate.

Example: *`sbr 9600`*

3.11 Setting Gains

Optimizing gain in the analog domain allows you to achieve a better signal-to-noise ratio (dynamic range). As a result, perform all analog gain adjustments with **`sag`** and **`sg`** command.

Setting Analog Gain for Tap to Tap Matching

The set analog gain command allows you to adjust the analog gain in four channels for precise control over tap-to-tap matching.

This value is directly written to the video processor and does not take into account the 0dB gain reference. Current value of analog again may be obtained from **`gcp`** outputs. Since taps that have been modified with the **`sag`** command do not allow for dB gain reference, these values will not be displayed by **`gcp`** outputs. Gain values entered by way of the **`sag`** command are not saved with user settings.

If **`sag`** is changed, then the mapping should be updated by **`ugr`** command. If this is not done, dB value could get outside of allowed range.

`sag` command is mostly used for responsivity and tap matching calibration at factory.

To set the analog gain, use the command:

Syntax: *`sag t i`*

Syntax Elements: *`t`*

`0` - all taps

1-4 - Tap count (select single tap)

i

0-1023. 0 corresponds to low gain, 1023 corresponds to high gain

Related Commands: ***gag ; ugr***

Example: ***sag 0 27***

Update Gain Reference

Command **ugr** is to update 0dB gain reference to be equal to the current value of analog gain setting. It is the DN value currently set to the video processor's gain registers that is used as the gain reference. As such, values entered via the **sag** command) as well as the **sg** command are equally applicable. Gain references are saved with user settings.

Syntax: **ugr**

Set Gain (sg)

Command **sg** is for setting analog gain in the video processor. The value written to the video processor is summed with the 0dB gain reference. Current value of analog gain may be obtained from **gcp**, and **gag** outputs. Gain settings entered by way of the **sg** command are saved with user settings. If just higher responsivity is needed on all taps, the easiest way is to send a command **sg *0 x***.

To set the analog gain, use the command:

Syntax: ***sg t i***

Syntax Elements: ***t***

0 - all taps

1-4 - Tap count (select single tap)

i

0.0 – 24.0 in dB, 0 corresponds to low gain, 24 corresponds to high gain

Related Commands: ***gag ; gcp***

Example: ***Sg 0 0***

3.12 Monitoring the Camera

Note: When more than one condition is active, the LED indicates the condition with the highest priority. Error and warning states are accompanied by corresponding messages further describing the current camera status.

The camera is equipped with a red/ green LED used to display the operational status of the camera. Table 6 below summarizes the operating states of the camera and the corresponding LED states.

Table 6: Camera Operating States

LED state	Priority	Camera Status	Condition
Blinking RED	1	Error	Fatal hardware failure
Steady RED	2	Warning	Monitoring task failure
Blinking GREEN	3	Progress	Lengthy operation in progress
Steady GREEN	4	OK	Healthy

3.13 Rebooting the Camera

The command **`rc`** reboots the camera. The camera starts up with the last saved settings.

3.14 Setting the Video Mode and Generating Test Patterns

To set the video mode, use the command:

Syntax: ***`tps i`***

Syntax Elements: ***`i`***

- ***`0`*** video
- ***`1`*** Test pattern 1
- ***`2`*** Test pattern 2

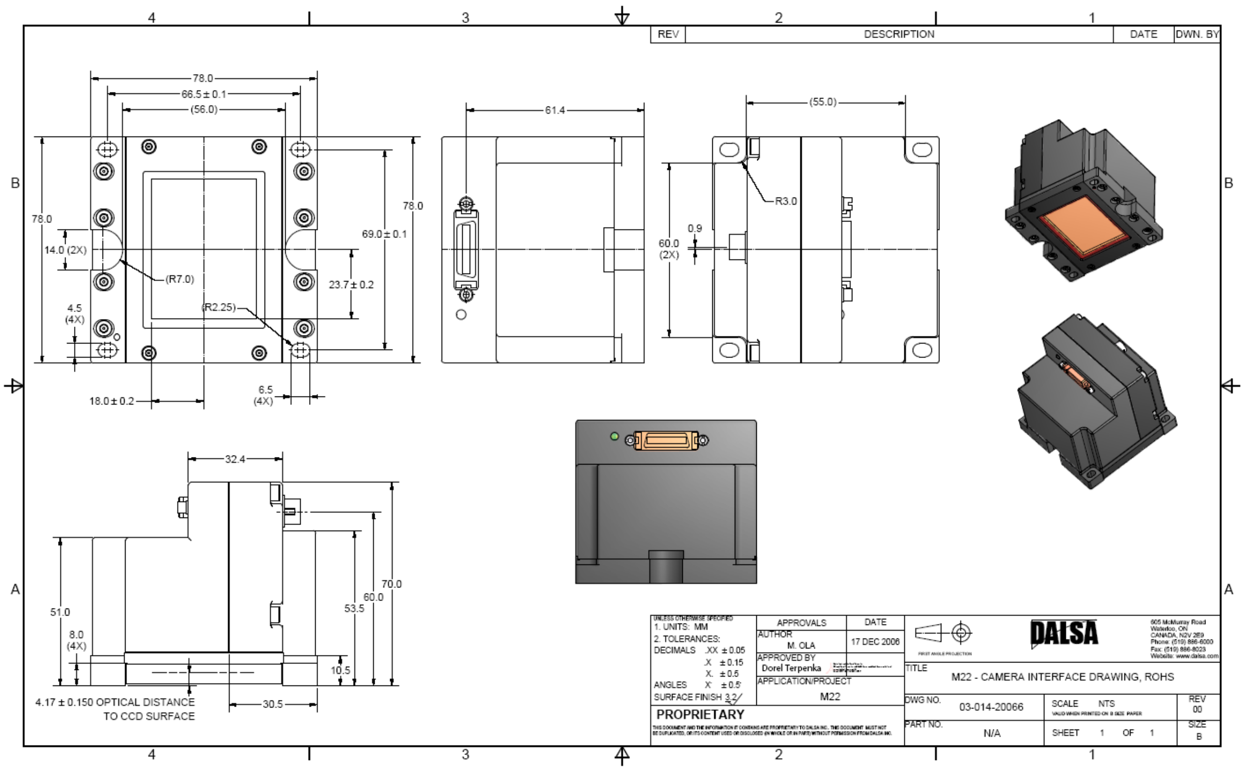
Example: ***`tps 0`***

4

Optical and Mechanical Considerations

4.1 Mechanical Interface

Figure 6: Mechanical Drawing



4.2 Mounting the Camera

The PANTERA 22Mcameras can be mounted via the 4 holes.

4.3 Thermal Management

For any CCD camera optimal performance is achieved by transferring heat away from the sensor. Keeping a sensor "cool" reduces the amount of dark current generated. Dark current is the leading contributor to FPN, PRNU, dark offset, random noise and other performance specifications, especially when a camera is significantly gained (i.e. +10db).

PANTERA 22M mechanicals have been optimized to transfer heat from the sensor to the front of the housing. Recommend to mount camera on a metal plate. Mount fans away from the camera to avoid vibration, and direct the airflow across the housing to decrease the temperature delta between ambient and housing temperatures. Proper installation greatly reduces dark current and will improve you systems performance.

4.4 Environment

The camera and cables should be shielded from environmental noise sources for best operation. The camera should also be kept as cool as possible. The specified operating temperature is -10–50°C measured at the front surface of the camera.

5

Cleaning and Maintenance

5.1 Cleaning

Electrostatic Discharge and the CCD Sensor

Charge-coupled device (CCD) image sensors are metal oxide semiconductor (MOS) devices and are susceptible to damage from electrostatic discharge (ESD). Although many sensor pins have ESD protection circuitry, the ESD protection circuitry in CCDs is typically not as effective as those found in standard CMOS circuits.

Electrostatic charge introduced to the sensor window surface can induce charge buildup on the underside of the window that cannot be readily dissipated by the dry nitrogen gas in the sensor package cavity. When charge buildup occurs, surface gated photodiodes (SGPDs) may exhibit higher image lag. Some SGPD sensors may also exhibit a highly non-uniform response when affected by charge build-up, with some pixels displaying a much higher response when the sensor is exposed to uniform illumination. The charge normally dissipates within 24 hours and the sensor returns to normal operation.

Preventing ESD Damage

To prevent ESD damage, we advise you to take the following handling precautions.

1. Ground yourself prior to handling CCDs.
2. Ensure that your ground and your workbench are also properly grounded. Install conductive mats if your ground or workbench is non-conductive.
3. Use bare hands or non-chargeable cotton gloves to handle CCDs. NOTE: Rubber fingercots can introduce electrostatic charge if the rubber comes in contact with the sensor window.
4. Do not touch the window, especially in the region over the imaging area.
5. Ground all tools and mechanical components that come in contact with the CCD.
6. We recommend that CCDs be handled under ionized air to prevent static charge buildup.

   The above ESD precautions need to be followed at all times, even when there is no evidence of CCD damage. The rate which electrostatic charge dissipates depends on numerous environmental conditions and an improper handling procedure that does

not appear to be damaging the CCDs immediately may cause damage with a change in environmental conditions.

Protecting Against Dust, Oil, and Scratches

The CCD window is part of the optical path and should be handled like other optical components, with extreme care.

Dust can obscure pixels, producing dark patches on the sensor response. Dust is most visible when the illumination is collimated. The dark patches shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse.

Dust can normally be removed by blowing the window surface using an ionized air gun.

Oil is usually introduced during handling. Touching the surface of the window barehanded will leave oily residues. Using rubber fingercots and rubber gloves can prevent contamination. However, the friction between rubber and the window may produce electrostatic charge that may damage the sensor. To avoid ESD damage and to avoid introducing oily residues, avoid touching the sensor.

Scratches diffract incident illumination. When exposed to uniform illumination, a sensor with a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels will change with the angle of illumination.

Cleaning the Sensor Window

Equipment Required

- Glass cleaning station with microscope within clean room.
- 3M ionized air gun 980 (http://solutions.3mcanada.ca/wps/portal/3M/en_CA/WW2/Country/)
- Ionized air flood system, foot operated.
- Swab (HUBY-340CA-003) (http://www.cleancross.net/modules/xfsection/article.php?articleid=24)
- Single drop bottle (FD-2-ESD)
- E2 (Eclipse optic cleaning system (www.photosol.com)

Procedure

- Use localized ionized air flow on to the glass during sensor cleaning.
- Blow off mobile contamination using an ionized air gun.
- Place the sensor under the microscope at a magnification of 5x to determine the location of any remaining contamination.
- Clean the contamination on the sensor using one drop of E2 on a swab.
- Wipe the swab from left to right (or right to left but only in one direction). Do this in an overlapping pattern, turning the swab after the first wipe and with each subsequent wipe. Avoid swiping back and forth with the same swab in order to ensure that particles are removed and not simply transferred to a new location on the sensor window. This procedure requires you to use multiple swabs.
- Discard the swab after both sides of the swab have been used once.
- Repeat until there is no visible contamination present.

5.2 Maintenance

There are no user serviceable parts on this camera. Please contact Teledyne DALSA for service.

6

Troubleshooting

The information in this chapter can help you solve problems that may occur during the setup of your camera. Remember that the camera is part of the entire acquisition system. You may have to troubleshoot any or all of the following:

- power supplies
- frame grabber hardware & software
- light sources
- operating environment
- cabling
- host computer
- optics
- encoder

Your steps in dealing with a technical problem should be:

1. Try the general and specific solutions listed in sections 6.1, 6.2, and 6.3.
2. If these solutions do not resolve your problem, see section 6.4 on getting product support.

6.1 Common Solutions

Connections

The first step in troubleshooting is to verify that your camera has all the correct connections.

Power Supply Voltages

Check for the presence of all voltages at the camera power connector. Verify that all grounds are connected.

EXSYNC

When the camera is powered on for the first time, the factory setting is default(no external inputs required). After you have saved settings, the camera powers up with the saved settings next time it is rebooted.

Data Clocking/Output Signals

To validate cable integrity, have the camera send out a test pattern and verify it is being properly received.

6.2 Troubleshooting Using the Serial Interface

The following commands can aid in debugging. (The complete command protocol is described in Appendix B.)

Communications

To quickly verify serial communications send the help command. The **`h`** command returns the online help menu.

Verify Parameters

To verify the camera setup, send the **`gcp`** command.

Verify Factory Calibrated Settings

To restore the camera's factory settings, send the **`rfs`** command.

After executing this command send the **`gcp`** command to verify the factory settings.

Verify Timing and Digital Video Path

Use the test pattern feature to verify the proper timing and connections between the camera and the frame grabber and verify the proper output along the digital processing chain. See below.

Generating Test Patterns

The camera can generate a test pattern to aid in system debugging. Use the command **`svm i`** to activate the test pattern (see section 3.14 Setting the Video Mode and Generating Test Patterns for details). The test pattern is a ramp from 1 to the number of pixels in the line, then starts at 1 again. Use the test pattern to verify the proper timing and connections between the camera and the frame grabber.

- **No test pattern or bad test pattern** — May indicate a problem with the camera (e.g. missing bit) or a system setup problem (e.g. frame grabber or timing). Verify the presence of the LVAL and STROBE signals.
- **Test pattern successful** — Run the **`svm 0`** command to deactivate video correction.

Verify Temperature

To check the camera's internal temperature, use the **`vt`** command. If it is within the proper range, the camera returns OK>. Otherwise the camera returns an error message.

LED Status

Located on the back of the camera is a red/ green LED used to display the operational status of the camera. Red lights indicate errors or warnings and green lights indicate progress and OKs. Error and warning states are accompanied by corresponding messages further describing current camera status. See section 2.2.1 LED Status Indicator for the complete LED information.

6.3 Specific Solutions

No Output or Erratic Behavior

If your camera provides no output or behaves erratically, it may be picking up random noise from long cables acting as antennae. Do not attach wires to unused pins. Verify that the camera is not receiving spurious inputs (e.g. EXSYNC, if camera is in exposure mode that regulates external signals).

Line Dropout, Bright Lines, or Incorrect Frame Rate

Verify that the frequency of the internal sync is set correctly, or when the camera is set to external sync that the EXSYNC signal supplied to the camera does not exceed the camera's maximum specified frame rate.

Noisy Output

Check your power supply voltage outputs for noise. Noise present on these lines can result in poor video quality. Low quality or non-twisted pair cable can also add noise to the video output.

Dark Patches

If dark patches appear in your output the optics path may have become contaminated. Refer to the sensor cleaning procedure in Chapter 5. for proper cleaning instructions.

Horizontal Lines or Patterns in Image

A faulty or irregular encoder signal may result in horizontal lines due to exposure time fluctuations; ensure that your exposure time is regular. If you have verified that your exposure time is consistent and patterns of low frequency intensity variations still occur, ensure that you are using a DC or high frequency light source.

6.4 Product Support

If there is a problem with your camera, collect the following data about your application and situation and call your Teledyne DALSA representative.

Note: You may also want to photocopy this page to fax to Teledyne DALSA.

Customer name	
Organization name	
Customer phone number **fax number**	
Complete Product Model Number (PT-21-11M04, PT-21-06M08...)	
Complete Serial Number	
Your DALSA Agent or Dealer	
Acquisition System hardware (frame grabber, host computer, light sources, etc.)	
Acquisition System software (version, OS, etc.)	
Power supplies and current draw	
Data rate used	
Control signals used in your application, and their frequency or state (if applicable)	❑ EXSYNC Other _______
Results when you run the gcp command	
Detailed description of problem encountered.	*please attach description with as much detail as appropriate*

In addition to your local Teledyne DALSA representative, you may need to call Teledyne DALSA Technical Sales Support:

	North America	Europe	Asia
Voice:	519-886-6000	+49-8142-46770	519-886-6000
Fax:	519-886-8023	+49-8142-467746	519-886-8023

Appendix A

Camera Link™ Reference, Configuration and Image Construction

Camera Link is a communication interface for vision applications. It provides a connectivity standard between cameras and frame grabbers.

LVDS Technical Description

Low Voltage Differential Signaling (LVDS) is a high-speed, low-power general-purpose interface standard. The standard, known as ANSI/ TIA/ EIA-644, was approved in March 1996. LVDS uses differential signaling, with a nominal signal swing of 350mV differential. The low signal swing decreases rise and fall times to achieve a theoretical maximum transmission rate of 1.923 Gbps into a loss-less medium. The low signal swing also means that the standard is not dependent on a particular supply voltage. LVDS uses current-mode drivers, which limit power consumption. The differential signals are immune to ±1 V common volt noise.

Camera Signal Requirements

This section provides definitions for the signals used in the Camera Link interface. The standard Camera Link cable provides camera control signals, serial communication, and video data.

Video Data

The Channel Link technology is integral to the transmission of video data. Image data and image enable signals are transmitted on the Channel Link bus. Four enable signals are defined as:

- FVAL—Frame Valid (FVAL) is defined HIGH for valid lines.
- LVAL—Line Valid (LVAL) is defined HIGH for valid pixels.
- DVAL—Data Valid (DVAL) is defined HIGH when data is valid.
- Spare— A spare has been defined for future use.

All four enable signals must be provided by the camera on each Channel Link chip. All unused data bits must be tied to a known value by the camera. For more information on image data bit allocations, refer to the official Camera Link Road Map specification on the www.teledynedalsa.com Web site.

Camera Control Signals

Four LVDS pairs are reserved for general-purpose camera control. They are defined as camera inputs and frame grabber outputs. Camera manufacturers can define these signals to meet their needs for a particular product. The signals are:

- Camera Control 1 (CC1)
- Camera Control 2 (CC2)
- Camera Control 3 (CC3)
- Camera Control 4 (CC4)

Communication

Two LVDS pairs have been allocated for asynchronous serial communication to and from the camera and frame grabber. Cameras and frame grabbers should support at least 9600 baud. These signals are

- SerTFG—Differential pair with serial communications to the frame grabber.
- SerTC—Differential pair with serial communications to the camera.

The serial interface will have the following characteristics: one start bit, one stop bit, no parity, and no handshaking. It is recommended that frame grabber manufacturers supply both a user interface and a software application programming interface (API) for using the asynchronous serial communication port. The user interface will consist of a terminal program with minimal capabilities of sending and receiving a character string and sending a file of bytes. The software API will provide functions to enumerate boards and send or receive a character string. See Appendix B in the Official Camera Link specification on the Web site (http://www.teledynedalsa.com/mv/knowledge/appnotes.aspx).

Power

Power will not be provided on the Camera Link connector. The camera will receive power through a separate cable. Camera manufacturers will define their own power connector, current, and voltage requirements.

Camera Link™ Configuration Table

The following table provides tap reconstruction information. DALSA is working with the machine vision industry to use this table as the basis for auto configuration. Visit the Web site and view the DALSA Camera Link Implementation Road Map document for further details (http://www.teledynedalsa.com/mv/knowledge/appnotes.aspx).

PANTERA 22M Interface Parameters

Table 2: Frame Grabber Interface Parameters (Unverified)

Item (when programmable configuration the options are separated with a |)	PANTERA 22M
Imager Dimension <1,2 or 1| 2>	2
Imager Columns<number of active columns, X>	4008
Imager Rows<number of active rows, Y> Line Scan/ TDI are defined as 1	5344
Number of Imager Taps <1,2,3…..>	4
Tap Clock Rate <xx MHz>	27
Camera Standard <NTSC, PAL, VS, VW, MW>	VS
Variable Window <Column Start, Column End, Row Start, Row End>	(0,0,0,0)
Multiple Window Number of Windows, (Column Start 1, Column End 1, Row Start 1, Row End 1) (Column Start 2, Column End2, …	0,(0,0,0,0)
Camera Color <Hybrid, Mono, Pattern, Solid>	Mono
Pattern Size <(T1,Columns*Rows)(T2, Columns*Rows)(T3,Columns*Rows….>	TBD
Color Definition <T1= R,G,B, CY, MG, Y, or M>	TBD
Row Color Offset <0,1,2,3…>	0
Column Color Offset <0,1,2,3…>	0
Number of Camera Configurations<1,2,3,…>	TBD
Configuration Definition Cx= HDW, Number of Output Taps, Bit Width, Number of Processing Nodes where Cx is the configuration ID x is <1,2,3…> HDW is <Base, Medium, Full> Number of Output Taps is <1,2,3…> Bit width is <8, 10,12…> Number Processing Nodes is <1 or 2>	C1 = Base 4, 12, 1 C2 = Base 4, 10, 1 C3 = Base 4, 8, 1
Tap Reconstruction In some configurations the reconstruction may change. C0 is the default output format and must be listed. Output configurations that don't conform are listed separately. <Cx,Tn (Column Start, Column End, Column Increment, Row Start, Row End, Row Increment>	TBD
Row Binning Factor <1,2,3 or 1| 2| 3>	1
Column Binning Factor <1,2,3 or 1| 2| 3>	1
Pretrigger Pixels <0,1,2…or 0..15>	TBD (programmable)
Pretrigger Lines <0,1,2.. or 0..15>	0
Frame Time Minimum <xx us>	278 000
Frame Time Maximum <xx us>	TBD
Internal Frame Time Resolution <xx us> 0 if not applicable	1

Item (when programmable configuration the options are separated with a |)	PANTERA 22M
Pixel Reset Pulse Minimum Width <xx ns> 0 if not applicable	0
Internal Pixel Reset Time Resolution <xx ns> 0 if not applicable	0
Pixel Reset to Exsync Hold time <xx ns>	TBD
BAUD Rate <9600….>	9600
CC1 <Area mode>	Smart Exsync
CC2 <TDI mode>	Line Sync
CC3 <Area/ TDI mode >	Selectable
CC4 <Spare>	Spare
DVAL out <Strobe Valid, Alternate>	Data Valid, held high except in binning modes
FVAL out <Frame Valid, Alternate>	Frame Valid
LVAL< Frame Valid, Alternate >	Line Valid

PANTERA 22M Image Construction

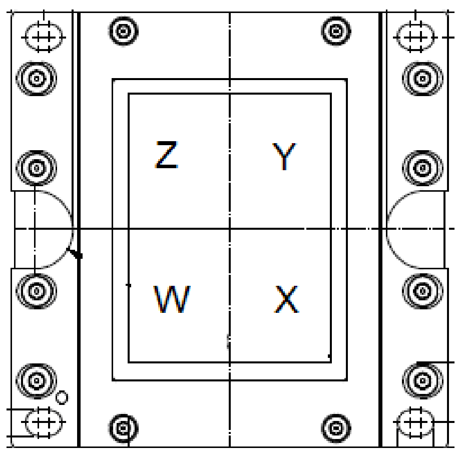


Table: Data channels configuration

22M03 tap	Data channel#, default configuration	Data channel#, custom configuration(for use with Xcellera PX-4 framegrabber)
W	1	1
X	3	2
Z	2	3
Y	4	4

Appendix B

Commands and Error Handling

This table provides a brief overview of all of the available user commands. For a detailed explanation of these commands, refer to Chapter 3.

Parameters:

`i` = integer
`f` = float
`t` = tap

Table: All Available CommandsTable 3Table 4

Command	Syntax	Parameters	Description
FPGA configuration store	***fcs***		Place the camera into FPGA code download state. Use HyperTerminal application to download the binary image of the FPGA configuration the file, the camera needs to be reset or power cycled. Before starting the download process with this commend, the camera's serial data rate should be increased by using the ***sbr***. A baud rate of 115200 is recommended.
get analog gain	***gag***		Read the camera analog gain
get analog offset	***gao***		Read the camera analog offset
get camera model	***gcm***		Read the camera model number
get camera parameters	***gcp***		Read all of the camera parameters.
get camera serial	***gcs***		Read the camera serial number
get camera version	***gcv***		Read the firmware version and FPGA version
get sensor serial	***gss***		Read the sensor serial number
help	***h***		Display the online help
camera link mode	***clm***	***i***	Sets the data mode to use. Available values are: `0`: 12 bit mode `1`: 10 bit mode `2`: 8 bit mode
reset camera	***rc***		Reset the entire camera (reboot)
restore factory settings	***rfs***		Restore the camera's factory settings.
restore user settings	***rus***		Restore the camera's last saved user settings.

Parameters:

i = integer
f = float
t = tap

Command	Syntax	Parameters	Description
set analog gain	***sag***	***t i***	Setting analog gain to video processor. `0~4, 0~1023`
set gain	***sg***	***t i***	Setting analog gain in the video processor. `0~4, 0.0~24.0`
set sync frequency	***ssf***	***t i***	Sets the camera's frame rate and line rate values. Current line rate may be obtained from G*et_Camera_Parameters* output. Sync rate information is saved with user settings. T= OPERATING_MODE: 1 – Frame rate 2 – Line rate FRAME_RATE: [T = 1] i= 278 – 16383 milliseconds LINE_RATE: [T = 2] i= 2780 – 16383 counts of pixel clock
set baud rate	***sbr***	***i***	Set the speed of camera serial communication port. Baud rates: 9600, 14400, 19200, 28800, and 115200. Default baud: 9600
Set sync mode	***ssm***	***i***	Sets the sync mode to internal or external. Sync mode is saved with user settings. 0- Internal sync 1- External sync
set operating mode	***tdi***	***f f***	Sets the camera's operating mode. Operating mode is saved with user settings. 0- CC3 External 1- Area Mode 2- TDI mode
set exposure time	***set***	***f***	Set the exposure time. Value is a number in microseconds in a range from 1 to 10,000,000.
set exposure mode	***sem***	***i***	Set the exposure mode. Available values are: 0 – Smart ExSync 1 – Frame Sync Internal, Exposure Internal 2 – Frame Sync External, Exposure Internal
set output mode	***sos***	***i***	Sets whether to read out data using one or two taps. Use **1** for one tap or **2** for two taps.
set exposure time	***set***	***i***	Sets the camera's exposure time in microseconds. Exposure time is saved with user. I = 1 – 10,000,000uS

Parameters:

`i` = integer
`f` = float
`t` = tap

Command	Syntax	Parameters	Description
set tdi direction	***scd***	***i***	Set video mode. Available values are: `0`: Top to Bottom `1`: Bottom to Top
Test pattern select	***tps***		Selects between video output, test pattern 1, and test pattern 2 output. Test pattern mode is saved with user settings. TEST_PATTERN: 0 – video 1 – test pattern 1 2 – test pattern 2
write user settings	***wus***		Write all of the user settings to EEPROM
update gain reference	***ugr***		Updates 0dB gain reference to be equal to the current value of analog gain setting. It is the DN value currently set to the video processor's gain registers that is used as the gain reference. As such, values entered via the **sag** command (*Set_Analog_Gain*) as well as the **sg** command (*Set_Gain*) are equally applicable. Gain references are saved with user settings.
verify voltage	***vv***		Measures and reports the external voltage supply provided to the camera.

Index

P

R

S

T

V

Revision History

DATE	Revision	Action	Originator
23/ 05/ 2008	00	Initial Release	Lawson Luo
19/ 11/ 2009	01	See detail below	Lawson Luo
08/ 19/ 2011	02	-Update to cosmetic blemish and sensor cleaning procedure -Restored missing labels to timing diagrams.	Gary Gagne

Details of the changes at version 01:

1. On page 26 in the second to last sentence it says "there values will not be displayed by gcp outputs" has been corrected to "these values"
2. On page 27 it says "digital gain" has been changed to "analog gain"
3. On page 26 the sentence that says "Current value of analog again may be obtained from gcp outputs." Has been changed to "Current value of analog gain may be obtained from gcp outputs."
4. Cover picture has been updated.
5. On pa25, section 3.9, setting the camera link data mod, line 1, “the PANTERA 22M camera have four tapes, each are 12 bits” “The PANTERA 22M camera CameraLink port has two taps (channels), each are 12 bits.
6. On page 25, section 3.9, “The 28 bits of data that are sent from the camera to the frame grabber are divided into three ports: A, B, C. Each port is 8 bits.” Has been changed to “The 24 bits of data that are sent from the camera to the frame grabber are divided into three ports: A, B, C. Each port is 8 bits.”
7. On page 26-27, definitions of ugr and sg have been added into chapter 3.11 setting analog gain.
8. On page 39 and 40. the website address “heep:/ / vfm.dalsa.com” has been changed to “www.dalsa.com”
9. On page 42, the Table: Data channels configuration has been updated.
10. On page 44, the description of the command ***sag*** and ***sg*** of have been updated.
11. Footer has been updated with the reflection of version 01.
12. Picture on the front page has been updated.